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AOARD REPORT

The FRIEND21 Project for the Development of the Next Generation Human Interface

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T. Davis
AOARD

A summary of the '94 FRIEND21 International Symposium on the next generation human/computer interface, conducted Feb. 2-4, 1994 in Tokyo, Japan is presented, along with some background on the six year Ministry of International Trade and Industry (MITI) sponsored FRIEND21 Project. Abstracts of all symposium presentations (except the keynote address) are included. The keynote address, by Dr. Kochiro Tamura, Deputy Director-General of the Electrotechnical Laboratory, is included in its entirety. Also included are the titles of selected English language background papers from earlier phases of the FRIEND21 project. This report is prepared jointly with
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based upon information collected via symposium attendance, review of the symposium proceedings, a post symposium visit to the Institute for Personalized Information Environment (the MITI organization responsible for the FRIEND21 project), review of selected FRIEND21 background papers from earlier project phases, and conversations with other symposium attendees.

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The FRIEND21 Project for the Development of the Next Generation Human Interface

Abstract

A summary of the '94 FRIEND21 International Symposium on the next generation human/computer interface, conducted Feb. 2-4, 1994 in Tokyo, Japan is presented, along with some background on the six year Ministry of International Trade and Industry (MITI) sponsored FRIEND21 Project. Abstracts of all symposium presentations (except the keynote address) are included. The keynote address, by Dr. Kochiro Tamura, Deputy Director-General of the Electrotechnical Laboratory, is included in its entirety. Also included are the titles of selected English language background papers from earlier phases of the FRIEND21 project. This report is prepared jointly with

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1. FRIEND21 Project Background

The FRIEND21 Project was initiated in 1988 by the Japanese Ministry of International Trade and Industry to develop next-generation human/computer interface technologies. The title FRIEND21 is derived from "Future Personal Information Environment Development", with the suffix 21 indicating that the activity is targeted for the advanced information oriented society expected in the early 21st century. The six year project is scheduled to conclude on March 31, 1994 at the end of the Japanese Fiscal Year 1993.

When the FRIEND21 Project was begun in 1988, its administration was delegated by MITI to the newly created Institute for Personalized Information Environment, P.I.E., whose responsibilities include overseeing the research activities, conducting related technology surveys and assessments, and public promotion of the FRIEND21 Project. According to P.I.E. the total government expenditures for the six year project duration are ¥900M.

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Mr. Eiji Kuriyama is the Executive Director, Mr. Kenji Seno is the General Manager, Engineering Department and Mr. Daizo Kato is the Deputy Director, FRIEND21 Research Center.

As indicated in Section 2 below, a total of twenty sponsoring members, including thirteen electronics/computer/communications related companies, three publishing/printing companies and four banks, are participants in the FRIEND21 Project. P.I.E. is very proud of the fact that all of the original project sponsors continued their support for the entire duration of the FRIEND21 project.

P.I.E. operates the FRIEND21 Research Center (located in Tokyo) which is staffed by a mix of permanent P.I.E. researchers (project high of 14, currently 5) and researchers transferred to the center by the participating companies (project high of over 40, currently 30). Additionally, most of the participating companies also conduct FRIEND21 Project research at their own facilities.

The research activities conducted under the FRIEND21 Project can be divided into three phases. The first phase extended from the project commencement in 1988 through 1989. Its primary focus was the definition of a high level human interface research strategy. The complementary concepts of METAPHOR, in which the functionality a novice user wishes to invoke is represented in terms that permit application of the user's world knowledge, and AGENCY MODEL, a computer architecture for implementing the essential computational and interface tasks, emerged as the unifying research approach during this phase of the project. Also, the term METAWARE was coined to describe the software implementation of the AGENCY MODEL.

Phase two of the FRIEND21 Project extended from 1989 through 1991. During that period, a collection of selected METAWARE and AGENCY MODEL concept verification research tasks were pursued. Also during phase two, several supporting multimedia, display and presentation hardware surveys were conducted.

The concluding phase three of the FRIEND21 Project involved in-depth studies and development tasks on a variety of information structuring, human interface environment development toolsets, METAWARE and AGENCY MODEL topics. The technical content of the '94 symposium consisted primarily of presentations and demonstrations based on phase three research projects.

Included in the products of the FRIEND21 Project are a total of 76 published papers (through October 1993) and 75 patents, of which 31 are Japanese, 12 are U. S. and 33 are European. According to Mr. Daizo Kato, Deputy Director, FRIEND21 Research Center, all intellectual property rights belong either to the Japanese government or to P.I.E. and are available to the public for a fee.

During the course of the FRIEND21 project, an international symposium was held at two year intervals. the '94 International Symposium on Next Generation Human Interface is the last in the series. There are no plans by MITI/P.I.E. to extend the FRIEND21 Project or to generate any follow on human interface projects. It is assumed that the corporate sponsors will continue to pursue human interface research and development activities on their own. However, there may be other basic research projects of a comparable scale in other related areas, possibly in computer networks (see section 4 below).

2. Sponsoring Members:

The sponsoring members of the FRIEND21 Project are as follows:

Apple Operations and Technologies Japan Branch
IWANAMI SHOTEN, PUBLISHERS
N. T. T. Data Communications Systems Corporation
Oki Electric Industry Co., Ltd.
SHARP CORPORATION
The Sumitomo Bank, Ltd.
Sony Corporation
The Dai-Ichi Kangyo Bank, Ltd.
DAINIPPON PRINTING CO., LTD.
The Mitsui Taiyo Kobe Bank, Ltd.
TOSHIBA CORPORATION
TOPPAN PRINTING CO., LTD>
IBM Japan, Ltd.
NEC Corporation
Hitachi, Ltd.
Fuji Xerox Co., Ltd.
FUJITSU LIMITED
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
The Mitsubishi Bank, Ltd.
MITSUBISHI ELECTRIC CORPORATION

3. The '94 International Symposium on Next Generation Human Interface

The '94 symposium was conducted 2-4 Feb., 1994 at the Meguro Gajoen in Tokyo. The program was arranged in session blocks in which collections of presentations on a single theme were presented. Section 5 consists of abstracts of all symposium presentations (with the exception of the keynote address, which is included in its entirety), organized by session block and including author and sponsoring organization information. Included with some of the abstracts are summaries of the corresponding presentations from a parallel summary report by Dr. Paul Milgram, who is currently an Invited Researcher at the ATR Communication Systems Research Laboratories, Kyoto, Japan, on leave from his position as Associate Professor in the Department of Industrial Engineering, University of Toronto, Toronto, Ontario, Canada. Simultaneous English and Japanese language translations of all presentations were provided, and virtually all projection aids were in English.

The symposium was attended by about 200 people. With the exception of a few invited US/UK participants (see the concluding paragraph of this section), virtually all participants were Japanese nationals. The FRIEND21 sponsoring organizations were heavily represented.

The first session block, conducted Wednesday morning, consisted of keynote, guest and FRIEND21 project background presentations. The keynote speech, titled "Renewal of information processing paradigm", was delivered by Dr. Kochiro Tamura, Deputy Director-General, Electrotechnical Laboratory. As noted above, the corresponding paper is reproduced in its entirety in section 5. The Wednesday morning session also included a FRIEND21 project summary presentation by Mr. Daizo Kato, Deputy Director of the FRIEND21 Research

Center and a presentation by Professor Masumi Ishikawa of the Kyushu Institute of Technology on an attempt (not yet complete) to formalize a set of human interface design/development guidelines. A post symposium contact with P.I.E. indicates that the guidelines will be published in June or July, 1994.

The Wednesday afternoon session was devoted to a series of presentations, primarily theoretical/academic, on the "metaphor" approach to human/computer interfaces. Three invited US participants (see the concluding paragraph of this section), Dr. Austin Henderson, Professor Edwin Hutchins and Professor John Carroll presented papers during the session.

The Thursday morning session consisted of presentations on a variety of FRIEND21 Metaware projects, with emphasis on metaware (software) development environments. A highlight of the session was the presentation by Noburo Asahi of Mitsubishi Electric Corporation on the Metaphor Environment Construction Tools (MECOT).

Thursday afternoon was devoted to Agents and Information Environments. Professor Pattie Maes from the MIT Media Lab and Dr. Mik Lamming from Rank Xerox Research Center, Cambridge, UK delivered presentations during the session.

The topic for the Friday morning session was Agency Models. A particularly interesting project, a multimodal drawing tool developed at NEC Corporation, was reviewed by Mayumi Hiyoshi. It permits the user to employ voice, keyboard and mouse inputs in combination to access a drawing program.

The concluding session on Friday afternoon was devoted to panel discussions. Two separate panel discussions, one titled "What we learned from the FRIEND21 Project" and a second titled "Toward Future Personalized Information Environments" were conducted.

In conjunction with the symposium presentations, an interactive demonstration project area was established and manned by researchers from P.I.E. and the various corporate sponsors. A total of fifteen demonstration projects were established and manned. The demonstrations projects were organized into two broad categories, (1) those devoted to Metaware Development activities and environments and (2) those devoted to Agency Model research tasks. The demonstration projects, all of which have associated symposium presentation abstracts in section 5, are listed in section 6 below.

Although not directly involved in the FRIEND21 Project, several US/UK researchers engaged in the human/computer interface research arena were invited to the '94 International Symposium. Following is a list of invitees, each of whom presented a paper and most of whom served as panelists in the two concluding panel discussion sessions.

Dr. D. Austin Henderson, Manager, User Interface Architecture, Corporate Architecture, Corporate Research and Technology, Xerox Palo Alto Research Center

Professor Edwin Hutchins, Department of Cognitive Science, University of California, San Diego

Professor John M. Carroll, Department Head, Computer Science, Virginia Polytechnic Institute and State University (VPI & SU)

Dr. Michael G. Lamming, Senior Scientist, Rank Xerox, Euro Park

Professor Pattie Maes, Assistant Professor of Media Arts and Sciences, Media Lab, MIT

4. Comments

The MITI sponsors and their corporate counterparts clearly demonstrated remarkable foresight in selecting this project. They obviously recognized the commercial opportunities available in this enabling technology arena, and more to the point, over six years ago they implemented a project intended to begin the process of finding ways to exploit those opportunities. Or as one researcher put it, "it makes vivid the Japanese recognition that user interfaces are gating commercial and technological opportunities in computing." However, most of the research products of the project are modest at this point and the "metaware" ideas presented here have not developed much beyond those shown in 1991 (with the notable exception of the academic work, some of which is very interesting). On the other hand, the research infrastructure residual to this program should prove very valuable. The writer is not aware of any other comparable focused research program on human interfaces.

In addition to the obvious motives for pursuing this program, it appears that an ancillary objective is to answer criticism based on the widely held perception that Japan does not do its "fair share" to support long-term, basic research. Observations which indicate sensitivity to the criticism surface occasionally in discussions with project participants, and indeed it is almost stated directly in the project summary paper presented by Mr. Daizo Kato, Deputy Director, FRIEND21 Research Center during the opening session block. The FRIEND21 project is by its very nature a fundamental, long term basic research venture of the sort which might discourage corporate investment, but which is a necessary first step. It is an effective rebuttal to the criticism. It is also worth noting that public promotion of the project is one of P.I.E.'s explicitly assigned project responsibilities, and that they take that responsibility seriously.

One of the stated goals of the FRIEND21 project is that the human interface architecture which emerges from the project will develop into a de facto standard for 21st century human interfaces. In fact a detailed list of interface standards is to be published later this year. However, a consensus opinion among consulted symposium attendees is that this goal (that the project's standards will dominate) is highly unrealistic given the amount of commercial development in this area, and that commercial successes alone will dictate the emergence of de facto standards.

Another difficulty may be that the decision to focus on architecture, standards, and guidelines rather than to implement robust systems has limited the possible impact. The agent part of the project is very close to what many groups in the West are doing but real systems work would have helped to clarify thinking and to make compelling what has been done. However, a reasonable amount of interesting pre-competitive research ideas have been produced (Hirose's theory is an advance on previously published papers) and

there are many concrete directions to go from that work. Perhaps some proprietary efforts have already been spawned by FRIEND21 but not shown

A somewhat puzzling observation is that there appears to be little or no connection or cooperation between FRIEND21 and TRON (The Real Time Operating System Nucleus), which also includes a significant amount of human interface related research activity. In fact, the demonstrations of human interface at the TRON Symposium seemed more ingenious than the mostly prosaic ones shown here.

Finally, an obvious question is what P.I.E. will do following FRIEND21's March, 1994 conclusion. The FRIEND21 project is by far the largest activity on its plate. As noted in section 1 above, there are no plans to extend FRIEND21 or implement a follow on to it. However, there are indications that another project, comparable in scope and purpose, may be in the works and that it will probably focus on computer networking.

5. Papers Presented at the '94 International Symposium:

Following is the symposium keynote address by Dr. Kochiro Tamura and abstracts of all other papers presented at the symposium. The paper/abstracts are organized in the session block order discussed in section 3 above. Also included with some of the abstracts are summaries of the corresponding presentations from a parallel summary report by Dr. Paul Milgram, who is currently an Invited Researcher at the ATR Communication Systems Research Laboratories, Kyoto, Japan, on leave from his position as Associate Professor in the Department of Industrial Engineering, University of Toronto, Toronto, Ontario, Canada (e-mail milgram@atr-sw.atr.co.jp). Each of Dr. Milgram's summaries appears in brackets immediately following the corresponding abstract.

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Keynote, Guest and Project Background Presentations

Renewal of information processing paradigm

Koichiro Tamura
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Electrotechnical Laboratory

1. Recent paradigm shift in information industry

We are in the age of rapid change of computer technology. Although the computer history of 50 years has had incessant revolution, the recent change seems particularly drastic. To sum up the trend in the last decade, industrial weight shift has occurred, from hardware to software and in software from order-made to packaged one. The so called "Information society" emerges in this appearance. It may be predicted that the information companies that produce packaged software with good quality will prosper but those who rely only on hardware or ordered software will decline.

Down-sizing phenomena is of course in this trend. Most users are getting away from main frames and prefer personal computers and workstations. Why? Because the hardware is getting cheaper. Why? Because they can sell many. Why? Because the software that has nice functions with ease of use was developed. If it is still difficult to use for many people, they would surely never use computers even if they are cheap. The market would be limited and small. Then, who would owe the enormous cost of research and development that is essential to reduce the cost? Thus, some good packaged software with ease of use enlarged the market, that prompted the investment to develop hardware technology, that in turn increased the number of users tremendously.

Those are phenomenal shifts in the recent market and technology. I foresee, however, that more fundamental paradigmatic changes of information technology shall be necessary and actually about to happen to meet the users' satisfaction in the future.

2. From " ease to use " to " ease to make "

One can clearly divide the information technology into hardware and software. As my definition, software unit is an integration of programs and data those are supposed to be used by unspecified users. The remarkable characteristics of the software are (1) ease of copy, and (2) loadability of multiple units for one hardware. The success of Nintendo's game machine business is due to the shift to software after giving up to produce each hardware for each game. Computer hardware is general purpose with no function, and the software gives the function that is easily copied with few

cost. Computers are definitely different from TV or automobiles in this point. Users buy computers in order to use some software that gives function.

It seems obvious that the relative importance of software to hardware is increasing in terms of market sales, production cost, or the number of employees engaged in[1]. Unfortunately, we do not have exact statistics that shows this phenomenon, but our perception tells us that the weight of software has already exceeded over the one of hardware in the industry.

This phenomenon appears not to be limited only in information industry. Most kind of industries and many kind of social activities are strongly affected by software-oriented systems. Information society means to see this phenomenon in all branches of our social activities. It is not a rare case for one automobile to have more than 100 microprocessors. The total software for those microprocessors must be huge. It is said that a recent high-tech jet fighter loads software with over I million steps. The designers of automobiles or plains definitely need supercomputers with huge CAD software. To sum up, information society means software-shifted society.

The progress of software technology has been changing the way to use software. Computers used to be machines for users to program by themselves. Most users nowadays make use of software to have computers work as they want. In addition, less users want order-made software but packaged ones. In Japan, this change is occurring years behind other countries, that causes not only the lag of the software technology but also inefficient structure of the whole system of the country. It is obvious that mass produced (production of software means duplication with little cost), inexpensive software with high quality is much more efficient than order-made one. Unfortunately, such good packages are still few in Japan. The discussion on this matter is beyond the scope of this paper.

Although most users of more than 30 million personal computers in the world make use of packaged software, they are not completely satisfied with those. No package can meet completely what users want. That is why customization is necessary, and so called end-user computing are strongly demanded. Of course, most package software prepares some method for users to customize, but most users feel those are too difficult to exploit. Urged here is the shift from "ease to use" to "ease to make". In this sense, the way to use computers seems to change back to the old age when users programmed computers to use by themselves as they want.

3. Network age and software

Computer network has brought many to many communication whereas the telephone is one to one and the broadcast is few to many. People can enjoy a completely new kind of world by "surfing"' on the networks to communicate with other people and databases, small or large, and machines running interesting programs, however far away they are. Networking is thus the

[1]For example, Dr. Sekimoto , President of NEC, said, "I think software will be much important. I would exaggerate that one who conquers the software conquers the world. Anyway, we foresee the age of the software with much importance." (JAIDA Journal 35, 7 p.2 1993)

important side of information society, and its point is again its software; The software to back up and be delivered through the network is vital to attract users.

The software supplied through network includes not only computer software and date in databases but also CD music, video and multimedia-type. In addition, services such as barber shops that have been confined only locally thus far may be performed remotely through high speed network and remote operation technique. Even surgery operation can be done through long haul network. Many sort of services can be carried out on networks and distributed around the world. This is another big change we will see in the near future.

4. Computers in the near future

Recent software consume immense memory. Even simple Jobs in office automation often need more than 8 million byte RAM. If people want multimedia or AI solution, they may need more than 100 million bytes.

In the near future, a single user may use more than one computers at a time. Even now, we can see those who use 2 to 3 workstations and personal computers on his/her desk. If it is the case, we want some conditions to such computers as the followings.

(1) cheap,
(2) light,
(3) wide,
and
(4) large capacity of communication with the user.

Any computer that meets those conditions may look like a piece of paper, which is light, thin, wide with high resolution to input and output. In fact, FRIEND 21 Project supposed this kind of computers (we named "papyrus computer') and has pursued human interface system for those machines. Users would use some papyrus computers on his/her real desk like windows in desk top metaphor of the today's computers. Whiteboard size papyrus computers may be necessary. This prediction and expectation was held about 6 years age, but we think that this foresight is still effective and may come true in the first decade of the 21st century[2].

Needles to say, those machines may be connected with each other, hopefully by wireless. The human interface for them contribute to hide away the mechanism of computation as if users feel to use something but computers. GUI is one of the technique to hide away computers from users view. A large number of micro-computers are already exploited actually behind the scene, embedded in many kinds of industrial productions.

Users will never want a large capacity of memory accidentally evaporated. They should be non -volatile, that urges the necessity of the research and development for new type of RAM. Battery problem also needs some solution. They should have much longer life and be much thinner and lighter.

[2]Recently, the Ubiquitous Computing Project by XEROX PARC is pursuing the similar concept.

5. Computers in the far future

In the far future, how large memory do people want to use? I predict they will want it infinitely, if they can afford. In fact, CAD users nowadays use workstations with a few giga bytes RAM. It is possible for clerks in offices would want the same. Software itself grows larger exponentially with much more complexity and functionality, as well as data such as multimedia.

Software people should be afraid if it is possible forever to be supplied such enormous memory to cover the incessantly increasing size of programs and data. How about to accommodate AI programs? The essence of AI computation is search, which needs certainly very large size of memory space, and parallelism that of course needs much more hardware.

In nowadays, people do not believe in the effectiveness of AI technology. The Fifth Generation Project seems to show, however, that it is not software's shortfall but hardware's to back up the advanced software, since the project had developed languages and systems on the assumption that parallelism be available, and eventually resolved many difficult AI problems.

Some hardware people predict the limit of memory chip technology as several giga bits per chip. Right or wrong, there surely is some limit for any technology and the size of software will not stop increasing, although improvement of algorithm and techniques still goes on. We would see in decades a kind of catastrophe if we cannot change drastically the essential paradigm of computation.

6. Essential renewal of computational paradigm

Not only the limitation of hardware development urges the renewal of the computational paradigm. Even if AI technology has developed to some advanced level by the long efforts such as Fifth Generation Project, human intelligence is still mysterious from the standpoint of the information technology to date. For example, no computer can learn how to speak any natural language like a human infant easily does. The computation technology would be frozen ever as the automobiles with gasoline engine, if we cannot find completely different paradigm to mechanize intelligence.

The sentiment to demand this kind of paradigm shift has spotlighted "new" exotic computation concepts such as neural network, fuzzy theory, genetic algorithm, chaos theory and A-life. Those are, however, not new, and actually decades older. I may predict that none of those will take over the today's computation paradigm, although some can be supplemental to it. We need completely new representation of information and way of computation.

In terms of device technology, it is doubtful that it is effective forever to continue to pursue smaller unit cells. The another way to find a right model in biological systems is also doubtful, because it is too complex to understand the mechanism of biosystems from our knowledge to date. Research on the neuron and brain mechanism appears to me to presuppose that computation models working In the biosystem are similar to the today's computer mechanism. I doubt if they can find out any new paradigm from this kind of approach. New paradigm for intelligence should be find out by serious thought upon human intelligence as philosophical or religious thinking since thousands years ago.

Computer people may have a good chance to generate a brand new philosophy through their pursuit of mechanizing intelligence.

Summary of the FRIEND21 Project

Daizo Kato
FRIEND21 Research Center
Institute for Personalized Information Environment

The FRIEND21 Project began its research activities in 1988 with the goal of creating a human interface for the 21st century that allows for the pleasant, convenient, and efficient use of computers. For five years, research into human interface has been carried out in various ways with the help of participating companies, such as computer manufacturers, home electronics manufacturers, publishing companies, and printing companies. The FRIEND21 Project has proposed new design principles for the 21st-century human interface using contextual metaphors called "metaware", and new software architecture called the "agency model" for the implementation of metaware. We are now researching an "integration model", that systematically covers metaware, the agency model , and design environments for these frameworks and architectures.

At the end of March 1994, the FRIEND21 Project will conclude its six year research project. The results of this project are now and will continue to be open to the public.

Toward Guidelines for Friendly Interfaces

Masumi Ishikawa
Kyushu Institute of Technology

At the outset I will present brief history of standards in the field of information technology. In a human interface, which is one of the subareas of information technology, the immaturity and the rapid progress of its technology makes the standardization difficult. Hence, the need arises for guidelines and recommendations for the design of human interfaces. In the FRIEND21 project a novel human interface architecture comprising metaware and an agency model is proposed. It has pursued guidelines and recommendations based on this architectures as one of its major results. I will outline the efforts to date toward the guidelines and briefly summarize the project from the point of view of design guidelines and recommendations.

An Agenda for HCI

Austin Henderson
Manager, Use Architecture
Xerox Corporation

This paper presents my personal assessment of where the field of Human-Computer Interaction (HCI) is today, and a few key challenges it faces. This is presented in two parts: First, I discuss the current common framing of HCI, argue that it is centered on bringing a person to a computer, and propose that

it be re-centered on bringing computation to the everyday activity of people. Second, based on this change in perspective, I discuss a few aspects the activity that people do, particularly those employing technology, and for each show how we can improve the quality of HCI by better fitting in with the richer interactions of people's activity.

[Austin Henderson, Manager of Use Architecture at Xerox Corp., presented his personal view of the current emphasis in the field of Human-Computer Interaction (HCI) towards one person sitting in front of one computer, and how computation is destined to become more 'ubiquitous' as it permeates activities of people in everyday life, both inside and outside the office.]

Metaphor Presentations

Metaphors for Interface Design
Edwin Hutchins
University of California, San Diego

Computers are the most plastic medium ever invented for the representation and propagation of information. In fact, they are so adaptable and can manifest such a wide range of behaviors, that little but the hardware itself may be easily identifiable as an enduring property of the device. Computers can mimic the behaviors of other information media and can manifest behaviors that are simply not possible in any other medium. We might speak literally about the nature of the computer's behavior (to the extent we can speak literally about anything) at a very low level, describing the changes in the states of silicon gates and so on, but even there we frequently resort to metaphors. As the levels of complexity are layered one atop the other to produce the high-level behaviors that are the actions we recognize while interacting with the computer, the possibility of talking or thinking literally about the computer's behavior vanishes. We deal with this complexity and this plasticity by speaking metaphorically about the behavior of the computer. The metaphors we use both intentionally and unintentionally, contribute structure in terms of which we organize our understandings of what is going on (Lakoff & Johnson, 1980).

[Edwin Hutchins of the University of California at San Diego gave a talk on the underrated importance of metaphors for affecting the feel of interfaces and influencing the development of technology. His presentation gave a classification of different types of metaphors, under the headings of activity metaphors, mode of interaction metaphors and task domain metaphors. He subsequently concentrated on conversation metaphors, model-world metaphors and collaborative manipulation metaphors, all with respect to mode of interaction. It was especially encouraging to see that Professor Hutchins recognizes the fact that computer interfaces must go beyond merely enabling communication between the user and software packages, but must also take into account real-world tasks, as in process and vehicular control applications.]

The role of reflection in understanding systems

Naomi Miyake
School of Computer and Cognitive Sciences
Chukyo University

I have been interested in how reflection works in understanding and thinking. The problem of reflection has been identified and talked about in cognitive science. As one example, Don Norman maintains in one of his recent books that there are two modes of cognition, experiential and reflective (Norman, 1993).
Besides his observations, experimental studies have shown that laborious, reflective activities have their own merits (Miyake, 1990; 1991). For any interface, when one uses it, there occur reflective phases during the process. Identifying and analyzing such reflection might be useful for understanding better principles for interface design.
While you are at work, you can reflect upon what you are doing at the moment, on your own actions and on the reactions and feedback you get from the environment. As another type of reflection, you can also reflect upon the mentally recreated version of such a process, perhaps not at the moment, even without the same physical set up in the environment.
If we take an example of people trying to understand how to use an application software on a computer, the former is a part of what they think while they are trying its commands, getting reactions, feedback and everything. The latter is what they remember and think over later, perhaps away from the computer, by mentally looking back on their experience. I have been mainly interested in this latter type of reflection, because it is a mental process on a mental process, which has a potential of creating and modifying some possibly new perspective not bound by the physical constraints of reality. This could give us some freedom to, for example, stretch the limits of an action to see new possibilities. For the reflection on mental models to work, the mental models themselves have to be the decent representation of what could happen in the real, physical world.
I have been interested in finding out how the latter type of reflection leads to new perspectives, different ways to see the problem at hand, to new creation. Such findings should be useful for designing technological support for intellectual activities. In this paper I use the term "Reflection" to refer to this type of off-the-spot reflection. The main questions are, how the reflection promotes understanding, how much direct, interactive experience we need to build workable mental models for effective reflection, what extent of physical detachment is needed for establishing the reflection and the like. I try to answer some these questions, taking support from quasi-experimental research.

Binding Metaphors to Scenarios of Use

John M. Carroll
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Metaphor has proven to be one of the richest and most robust ideas in the design of computer applications and user interfaces. The basic idea is very simple; present functionality in such a way that the user can access and apply specific prior knowledge while learning and using a novel tool. But the practical and theoretical ramifications of this idea both in the brief history of human-computer interaction and in its current prospects are quite considerable. In this talk, I first summarize my view of the relevant history. I then develop the notion that metaphors should be conceived of as bound to contexts of use: The recognition and interpretation of metaphors typically depends upon the establishment of a meaningful task context. I think we need to focus our consideration of metaphors on the scenarios of use from which they arise. I suggest that this recognition of metaphors as bound to scenarios of use converges with recent developments in scenario-based specification and object-oriented design.

[John Carroll of Virginia Polytechnic Institute also argued the very important point that research on metaphors must take into account the task context, or in other words that scenarios of use must be developed as an integral part of interface design. Thus how the metaphor relates to the context of the task being performed is possibly much more important than the actual (physical) metaphor itself, which has most likely been developed outside of the task context.]

Interface Metaphors and their Roles in the learning of Computer systems

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University of Tsukuba
Hiroshi Nunokawa and Kiwamu Sato
Research Institute of Electrical Communication
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This paper addresses the roles of interface metaphors in the learning of computer systems. There are several earlier articles on interface metaphors (e.g., Carroll, Mack, & Kellogg, 1988; Henderson & Card, 1986; Hirose, 1991; Kusumi & Matsubara, 1993; Mander, Salmon, & Wong, 1992; Nonogaki, 1990). However, only a few studies have been presented on typology of interface metaphors. This study ;had three clear aims. First, we classify interface metaphors based on their cognitive function. Second, we proposed multiple interface metaphor; DoReMi (Sato, Nunokawa, & Noguchi, 1993), a graphical user interface for computer network systems based on the city metaphor. Third, we evaluate the interface metaphor by psychological experiment.

[Takashi Kusumi of the University of Tsukuba dealt with the importance of metaphor, analogy and personification in connecting domains, and of metonymy and synecdoche in connecting components within domains. Such concepts are of primary importance in facilitating the learning of new systems by novices. In addressing this need, Kusumi-san's group has developed the DoReMi system which is based on the metaphor of a city. Illustrations and evaluation results were given of tasks such as address look-ups via the metaphorical city office and Email posting through the metaphorical city post office.]

Metaware Project Presentations

An Environment for Developing Metaphor Worlds
- Toward a User-friendly Virtual work Space based on Metaware

Nobuo Asahi
Mitsubishi Electric Corporation

One of the most important issues on Human Interfaces is giving users suitable system images. Especially for non-expert users, the system image should be easy to understand without special knowledge of computers. Interface metaphors, which were primarily applied to the Xerox Star system (1), have been playing significant roles in giving easy system images of complex computer applications by adopting well-known entitles as user interface objects.
In the current graphical user interface toolkits (GUI toolkits, for sort), the notion of interface metaphors is partially used by preparing class objects which represent well-known entitles, such as buttons, sliders, menus and so on. Each of interface metaphors is easy to understand how to operate, however, the composed user interface often fails to show a system image of an application. This is because the GUI toolkits are designed to be general and simple so as to be applied various application interfaces, and because most of them are supplied as the sets of given class objects which make it difficult to create new class objects necessary to construct a suitable system image. Further more, as the GUIs are constructed by arranging objects two dimensionally, the screen size of a computer display would be a constraint to its design potential.

[Asahi (Mitsubishi Electric) reported on the MECOT (Metaphor Environment Construction Tools) system. Current graphical user interfaces (GUI's) usually lack the system image of an application, and since many systems are three dimensional, a tool for creating 3D metaphor environments is desirable. The MECOT system allows for rapid construction of various interfaces. Its architecture consists of Metaphor Editor, Environment Manager and Environment Builder. The Editor is used for creating objects. The Environment Builder is used for putting parts together to construct an environment, such as an office, with desks, drawers, filing cabinets, etc. in 3D. It was claimed that MECOT is suitable for rapid prototyping (95% fewer steps in comparison with C programming) and that the 3D animation capability encourages designers. Two tests were conducted. The first experiment (2 subjects) indicated that the 3D environment was easier to understand than the 2D environment, but it was difficult to know the distance between objects in 3D and difficult to manipulate objects in 3D. The second experiment (5 subjects) showed that local co-ordinates based on moving objects are best for object movement.]

Class Based Dynamic User Interface Environment

Masaya Ueda
Sharp Co.

We introduce an approach to build dynamic user interface environment on class based object oriented system. The world "dynamic" means that instances in the object oriented system can change their behavior after they are

created. Such a dynamic changeability is very advantageous feature to built flexible user interface environment.
Static (i.e., conventional) class based object oriented systems have the constraints on changeability and adaptability of instance behavior that result from binding instances irrevocably to a class. In these systems, instances can not change their behavior after they are created.
In the real world, we often bind some pieces of paper into a file. Static class based systems can not simulate the equivalent operation even though it is a very basic action in our daily life.
In class based environments, each paper and file has a corresponding class. Suppose that you created some new pieces of paper from their classes and wrote something on them; but you can not bind them into a file. They must change their behavior to be bound into a file. For example, they must have new functions such as "next page," "previous page," etc.; but they can't. Of course, you can make a new file instance from its class, but it is a file of blank papers. Similarly you can not take out a leaf from a file.
To bind existing pieces of paper into a file, they must change their behaviors without losing each identity (i.e., text, picture, color, cursor position, font, etc.). But in static class based systems, instances can not change their behavior after they are created.
Instance based programming is a solution to get more flexibility and adaptability, but we took another approach. We use class based system, and change the class of an existing instance dynamically to change its behavior. This way can comply with sometimes contradictory two requests, flexibility and robustness. We use Common Lisp Object System (CLOS) on Macintosh Common Lisp (MCL).

[Ueda (Sharp) reported on their work on class based dynamic user interface environments. The keyword here is "dynamic", which refers to the fact that the end user can change the behaviour of an interface after it is generated, as opposed to conventional static object oriented systems, in which objects are bound to a certain class. Since in the real world we often desire to change the attributes of objects (for example, by taking individual pieces of paper and combining them into a file) dynamic classes should have many advantages (if they don't become too confusing when too much flexibility is provided.)]

Visible Software Parts in Human Interface Design

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and Tetsuo Kinoshita
Oki Electric Industry Co., Ltd.

In a future personalized information processing environment, users' requirements for human interface (HI) will be more diversified than now. According to this, an important problem is how efficiently to design a HI which respective users will be satisfied. We have studied this problem from a viewpoint of presentation of Hi and proposed an effective design method of HI> Under the proposed method, the software parts which provide visible elements of a HI are called visible software parts, and then a framework for developing the visible software parts has been proposed in conjunction with FRIEND21 architecture. The visible software parts are defined together with various knowledge concerning the use/reuse of these parts. Using these knowledge, it

will be able to select and utilize suitable visible software parts in a design process of a HI based on users' requirements.
Various parts knowledge of visible software parts are mapped and represented in formal descriptions. And then, these descriptions are also reformed into another formal descriptions in order to retrieve visible software parts efficiently. As a result of above reformation, parts knowledge is represented by two kinds of knowledge modules called logical parts and physical parts. A logical parts represents knowledge of the use of visible software parts with respect to users' task. On the other hand, a physical parts represents knowledge of the usage of visible software parts in a HI software system to be designed. According to these logical/physical parts, the design support mechanisms of systematic acquisition, representation, and utilization of knowledge to use/reuse various visible software parts for HI design, can be realized.
In section 2, a framework for representing various knowledge regarding visible software parts in proposed based on a discussion of the visible software parts and a design task of a human interface system. In section 3, a design method of a human interface based on visible software parts is demonstrated and the proposed method is also evaluated in section 4.

[Iwane et al (Oki Electric Industry) emphasized the large expense associated with designing and implementing user demands into individual interfaces, especially as interfaces become more diversified, and how it is logically more economical to reuse portions of software that have already been designed. In addressing this problem, they classify software parts which provide visible elements of a human interface as "visible software parts", and in the talk they discussed the framework for representing these visible software parts and incorporating them into new interfaces.]

Sound Metaphors in 3D Space

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Tokyo Information Systems Research Laboratory
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Sound plays an important role in the operation and use of computers. To look further into the role played by sound, sound must be arranged in a practical, i.e., 3-dimensional environment and studied from different viewpoints. And, to scrutinize the various roles played by sound in a 3-dimensional space, we need to record various kinds of sound and arrange them over a 3-dimensional space. In the following paragraphs, the writer will describe a method for arranging and manipulating sound in a 3-dimensional space.
To implement such a sound environment, sound is handled 3-dimensionally using virtual reality techniques. To make it easy to manipulate sounds, they are represented as metaphors, allowing them to be dealt with directly in a 3-dimensional space. These metaphors reflects the properties of sounds or the shape of the sound sources. Once a sound has been converted into a metaphor, it can be manipulated inside a 3-dimensional space. To build up this system, tool and material metaphors and the concept of chambers have been employed. The chambers consist of a recording chamber, a shape-processing chamber and an experiential chamber. In the recording chamber, sound is recorded and a shape corresponding to the attributes of the sound is created. In the

shape- processing chamber, a shape conforming to the sound source is produced. Thus, a sound metaphor is completed. In the experiential chamber, the sound metaphor is arranged over a 3-dimensional space, so that a 3-dimensional type of sound can be experienced. This system is built around a graphics workstation and dedicated virtual reality (VR) equipment. The recording chamber and shape- processing chamber are located within the graphics workstation, and the experiential chamber, within the dedicated VR machine.

[Miwa et al (Matsushita Electric) emphasized the importance of sound manipulation in 3D space, as a step beyond current typical document processing tasks. The problems encountered when trying to work in this manner with sound are that sound is invisible, difficult to manipulate, and difficult to position in 3D space. The objective of the Matsushita project is to "metaphorise" sound using a chamber metaphor, where sounds are treated as materials that are manipulated by a set of tools in successive chambers. These latter include a recording chamber, a shape processing chamber, a trajectory generating chamber and an experiential chamber. The tools comprise means of changing sound volume, transforming and separating shapes, deleting sounds, and altering acoustics. The final sound icons are presented visually and manipulated within a virtual reality environment.]

A Metaphor Environment Based on Interactive Scenarios

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Sony Corporation

Metaphor environment is a kind of human-computer interface, and is constructed with some suitable metaphors for context. And it has a feature of showing the current operation contents and status of a computer system to its users in the contextual and understandable way (WAT90).
We have investigated metaphor environment (SAK93), and proposed a framework of the environment which consists of three major elements -- Hermeneutics, Image, and Task (Fig.1) (WAT93); the framework is named the HIT model after those elements. It represents the relation that a task can be mapped to an image by certain interpretation (hermeneutics), and shows a method how the current operation and status of the computer can be represented with an image which is easy to understand by the user.
In our framework, "Hermeneutics" is the basis on which a task (user's tenor) can be represented by an image (vehicle) as a metaphor. In an application system, the whole of interpretation is a kind of world, and has a role of guiding the user based on scenarios which have consistent stories. We have proposed that such a metaphor environment as a human-computer interface should be built based on the scenarios.
People who design and build the metaphor environment are system designers, and people who work in the environment are users. If there is a large gap between user-hermeneutics assumed by the designer and user's actual hermeneutics, the user feels that the human interface of the computer is hard to understand and difficult to use. However, it is impossible to make the interface in which designer-assumed hermeneutics and user's hermeneutics are completely the same.

For this reason, we think that we should consider users' point of view more importantly, and devised a repeated-design method for a flexible metaphor environment, with which the environment can adapt itself more suitable for the user while he/she uses an application program in the environment. Since understandability and usability are more important for computer beginners than experienced users, we focus on the beginners. From now on, we use the word "user" for the computer beginners.
In Chapter 2, we first describe the metaphor environment from user's viewpoint and discuss the user world which the system designer should assume. And we describe a design method of a virtual world in which users perform their tasks. Next, we illustrate our system called "Macro Browser" (OHB 93) as an example of the method in Chapter 3. Then, in Chapter 4, we explain an experiment on Macro Browser and give the evaluation of this system from a viewpoint of the environment's helpfulness and effectiveness to user's understanding and task performance. Finally, we conclude this paper with the importance of the framework of the metaphor environment which we proposed.

[Sakaguchi et al (Sony) described their work on metaphor environments based on interactive scenarios, where scenarios are used as a means of presenting to a user the correspondence between a series of tasks and a chain of pictures. The goal is to teach the user about possible actions permitted by the system through constraints, which are based on context. The metaphor environment is created iteratively by designing task transitions which make the user's objective possible, writing scenarios which express the task model to the user, and creating images based on scenarios that match each task. The authors' system for doing this is Macro Browser, which allows video viewing, creation, editing, playing, browsing, etc., all while recording the user's operating history.]

Visualizing Information by Metaware

Nobuyuki Makimura, Fujitsu Laboratories Ltd.
Eiichiro Yamamoto, Fujitsu Limited

In the 21st century, it is said we shall enter upon highly personalized information society. In its personal information environment, we shall be able to handle multimedia data.
In the FRIEND21 project, we were studying the Hypermedia Authoring System as one of tools which help almost all people express personal information. In that study, we supposed business presentation as one of current applications of hypermedia authoring systems. We defined three casts in presentation, the author who prepares the presentation materials, the performer who presents it, and the audience who observes it. We considered what metaphor is appropriate for each cast and what metaphor can be easily understood according to the difference of presentation environment and so on (1).
From this consideration, we reached the recognition that it is also important to express contents of information by some metaphors.
Meanwhile, in the FRIEND21 project, it has been mainly discussed how we can express functions or operations of the computer by using metaphor environment for the purpose of helping people easily understand these functions or operations. That is, the main subject there, is to help people

understand the computer operation to have access to or process or create information.
But, there exist not only operations but also information in the computer. Of course, it is important to understand the operations to have access to information etc., but it is also important to understand information itself. As information is abstract, it will become to be easily understood when it has concrete shape. For example, to understand the structure of an atom, it is useful to suppose its structure as that of the solar system. So we think that metaphors are effective also in case of expression of information.
In this paper, we consider metaphors which give forms to information and which help people understand information.

[Makimura and Yamamoto (Fujitsu) dealt with the important problem of visualizing information by metaware, that is, how to present information visually to users in an understandable fashion. To understand task information easily, we have to be able to answer questions encompassing What, Who, Why, Where, When and How. This particular talk concentrated on the why, where and when questions, which comprise such issues as comparisons, structures, relations, classifications and viewpoint. Their system uses the IntelligentPad on InterViews to generate views and allow dynamic changes in the way information is viewed and presented.]

Coordinating an interface agent with direct manipulation environments

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Fuji Xerox Co., Ltd.

In this paper, we propose a collaborative manipulation interface which includes an interface agent as the "dialogue partner" and direct manipulation interface as the "tools." These tools are shared and collaboratively manipulated by the user and the agent. It is thought that this interface system simulates human cooperative works. This interface has the same properties of the cooperative works. We describe the benefits of the collaborative manipulation interface. A prototype system for the group schedule management is also developed.

[Sonoda's (Fuji Xerox) paper dealt with coordinating interface agents with direct manipulation environments. Direct manipulation interfaces are those in which procedural knowledge lies with the user and the interface is viewed as a "tool". Intelligent agent type interfaces, on the other hand, are those in which the agent acts as a dialogue partner who understands the intentions of the user. Rather than using exclusively either one or the other, this paper proposed coordinating the use of both approaches collaboratively, as a means of enhancing co-operative work. In this complementary approach, the user learns from the agent/coworker, and gradually takes over the task as knowledge is acquired and as task circumstances dictate.]

Multiple-Metaphor Environment

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One of the most important issues discussed in this paper is whether interface metaphors will be abandoned thorough their repeated use. Instead of using a mouse or icons, we may type commands on keyboards directly: "read" files, "kill" windows, "arrest" processes. It seems that such interface metaphors have been abandoned. However, such commands do not literally refer to killing or arresting anyone. These kinds of expressions are merely interface metaphors that assist a user in understanding and experiencing what is happening inside the computer (1).
Interface metaphors are tools that help people understand and use computers. Given that people will utilize information media in almost all walks of life in the 21st century, we propose that interface metaphors should be able to accommodate a combination of interface metaphors flexibly, freely and dynamically in the same way that people can combine a finite number of words in a wide variety of ways to express their feelings. The metaware mentioned below offers a methodology for combining interface metaphors flexibly, freely, and dynamically.
Metaware aims at creating a Multiple-Metaphor Environment. The Multiple-Metaphor Environment can process both "synonymy" and "polysemy," which cannot be processed by most existing interface metaphors. Also, it possesses context sensitivity, which means that it can utilize both "synonymy" and "polysemy" in a positive way. At the same time, its time phase function is based on cognitively tractable scenarios.

[In an extended lecture, Hirose (Fuji Xerox) talked about the need for multiple metaphor environments (MME), the potential roles they can play, and some issues involved in putting them into practice. One of the problems with current interfaces is that most metaphors are context sensitive and their appropriateness can change as tasks, computer functions and users' levels of knowledge change. This presents a problem to designers about how to decide in advance what are optimal interface metaphors. Multiple Metaphor environments address this by providing synonymy / polysemy, multiplicity and context sensitivity, all within a common interface. The principal message of Hirose's talk was an interesting analysis of multiple metaphor cases in terms of a two-dimensional taxonomy, in which polysemy and synonymy trade off against each other along one continuum and spatiality and temporality along the other continuum. Outstanding issues include how to combine customization with identification, in order to provide the user with the preferred interface.]

Agents and Information Environments Presentations

Leaning Interface Agents

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Interface agents are computer programs that employ Artificial Intelligence techniques in order to provide assistance to a user dealing with a particular computer application. The paper discusses an interface agent which has been modeled closely after the metaphor of a personal assistant. The agent learns how to assist the user by (i) observing the user's actions and imitating them, (ii) receiving user feedback when it takes wrong actions, (iii) being trained by the user on the basis of hypothetical examples and (iv) learning from other agents that assist other users with the same task. The paper discuss how this learning agent was implemented using memory-based learning and reinforcement learning techniques. It presents actual results from two prototype agents built using these techniques: one for a meeting scheduling application and one for electronic mail. It argues that the machine learning approach to building interface agents is a feasible one which has several advantages over other approaches: it provides a customized and adaptive solution which is less costly and ensures better user acceptability.

[Maes (MIT Media Lab) gave an interesting account of work on intelligent agents modeled according to the metaphor of a personal assistant / collaborator. Such systems are expected to become more common as the need to augment the direct manipulation metaphor increases. Two important problems with such systems, however, are competence and trust. Two approaches to building interface agents were identified. In one class, the knowledge engineer programs the end-user program, which thus becomes the agent and is used at run time to infer user's goals; that is, it acts between the user and the application. The other (knowledge-based) approach, comprises an interface agent with a very large amount of fixed domain-specific knowledge about the application (domain model) and the user (user model). At run time the interface agent uses this knowledge to recognize the user's plans and provide assistance. Neither approach solves either the competence problem or the trust problem, since end users do not want to program the applications and since the knowledge engineer is not dealing with the end user. The Media Lab approach involves learning interface agents, which are similar to apprentices who are given some background knowledge but acquire most of their knowledge from observing the user, from being explicitly trained, and from consulting with other agents which have more experience. The examples presented included a personal assistant for meeting scheduling, a personal assistant for electronic mail, a personal editor for (electronic) news, and a personal agent for recommending books, movies, music, etc. Experiences with these systems thus far are quite promising, from the points of view of both competence and trust.]

Towards Intimate Interaction

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Keio University and Sony Computer Science Laboratory, Inc.
Akkikazu Takeuchi
Sony Computer Science Laboratory, Inc.

Intimacy means secure, piece of mind, trustworthy, reliable, and respect. Intimate interaction is the new notion of human-computer interaction, which is a basis of new human-computer interaction giving users such feeling. In the near future, computers become everyday tools that make our life convenient and comfortable. They will ;be used as an access terminal to

various networked services, and will be used as a communication terminal to other computers and humans. But they will be used, consciously or unconsciously, just as a conversation partner. Namely, the ultimate application is the dialogue itself. In this interaction, intimacy is essential to help people believe a computer as an individual agent. Through such interaction, people will believe a computer as an individual agent. Through such interaction, people will get the feeling of recognizing each other, understanding each other, and sharing common experience. In order to concretize the notion of intimate interaction, we have many research items to challenge. Among them, as a key technology, we pay special attention to multimodal interaction, especially speech dialogue with facial displays. The human face is an independent communication channel that conveys emotional and conversational signals encoded as facial displays. We are attempting to introduce facial displays into multimodal human computer interaction as a new modality to make computer more communicative and social. As a first step, we developed a multimodal human computer interaction system integrating speech dialogue and facial animation. The paper gives an overview of the notion of intimate interaction, and then describes the speech dialogue with facial displays system focusing on major research topics. They are to understand and manage speech dialogue, to design and animate communicative facial displays, and to combine multiple modalities, that is, speech and facial displays.

[Tokoro (Keio University & Sony) gave a rather philosophical talk on "intimate interaction" between humans and computers, which refers to the scenario in which the computer will be a ubiquitous tool with whom the user will share a sense of trust, security, reliance, and respect. (This scenario was illustrated by means of an entertaining video.) Tokoro's future cohabiting society of autonomous computers and humans encompasses a Computational Field Model comprising a continuously fluctuating sea of ubiquitous intercommunicating computers, in whose "computational field" objects "float" and are subject to real-time forces analogous to gravity and inertia. People will always carry with them their "Intimate Computer", which will act as an interface terminal with the Computational Field. One concrete aspect of multimodal human interaction with an autonomous volitional agent is the combination of the modalities of speech dialogue and facial displays, to create an interface in which the computer actually converses with the user. Examples were shown of the Sony face display dialogue system.]

"Forget-me-not"
Intimate Computing in Support of Human Memory

Mik Lamming and Mike Flynn
Rank Xerox Research Center

At RXRC we have been trying to understand how anticipated developments in mobile computing will impact our customers in the 21st century. One opportunity we can see is to improve computer-based support for human memory - ironically a problem in office systems research that has almost been forgotten. Considering how often computers are presented as devices capable of "memorizing" vast quantities of information, and performing difficult-to-memorize sequences of operations on our behalf, we might be surprised at how often they appear to have increased the load on our own memory.

The Forget-me-not project is an attempt to explore new ways in which mobile and ubiquitous technologies might help alleviate the increasing load. Forget-me-not is a memory aid designed to help with everyday memory problems: finding a lost document, remembering somebody's name, recalling how to operate a piece of machinery. It exploits some well understood features of human episodic memory to provide alternative ways of retrieving information that was once known but has now been forgotten.
We start by introducing a model of computing in the 21st century which we call the "Intimate Computing" model and talk about some of the opportunities and problems we anticipate it will provoke. After a cursory introduction to the basics of human episodic memory, we describe the architecture and user interface of Forget-me-not. We end with a few preliminary conclusions drawn from our early experiences with the prototype.

[Lamming (Rank Xerox Research Centre) gave an entertaining talk on intimate computing in support of human memory. He pointed out the anticipated need for a cheap reliable memory aiding device, as a future computing device which will have a market similar to that of today's digital wristwatch. The next revolution (analogous to Tokoro's vision) will be in mobile computing, and will comprise small computers which can be worn, which will communicate with each other via cellular communication, and will always know where they are. Work underway at EUROPARC is centered on trying to understand what the world will be like when everyone has an intimate computer on her wrist. For example, we will be able to exchange data with other people at any time, including during chance meetings on the street; we will be able to collect any data that we need, as we move around at any time; we will always have help in finding places, phone numbers, talk slides, etc. Our Personal Data Assistants (PDA's) will have access not only to our data bank, but also to our context , and thus will able to create episodic memory, by maintaining a list of episodes and generating scenarios based on this to allow probing of episodes. One exploratory area at Xerox is the Active Badges worn by all there, which are monitored by sensors all over the building, causing all movements to be stored in a log file. The kinds of things being learned include privacy and security issues, the difficulty of getting lost in the database, the need for reliability (memory, etc.), the need to improve performance (speed), the difficulties involved in translating raw data into events that the user will recognize, and the social implications of having "perfect memory".]

Agency Model Presentations

Agency Model for Acoustic Multimodal Interaction

Hidai Yutaka
FRIEND21 Research Center

We have proposed an Agency Model based on the Blackboard Model as human interface architecture for the 21st century. This paper describes a new attempt to add a framework for acoustic human interface to the Agency Model. At present, the sense of sight is used in the most advanced manner for human interface. However, the sense of hearing is just as important as the sense of sight for interaction with other human beings.

To make interactions more understandable, multimodal interaction technologies using multiple communication media/modes can be very helpful. Communication using a medium can include multimodal interactions. Another factor that improves comprehension for humans is transparency: internal data should be shown to users in a directly visible form. In addition, the processing of modes is important in multimodal interaction.
In acoustic multimodal interaction, it is important to synchronize the processing of various modules since time components are contained in respective communication modes. We propose to perform synchronization by logical time, which is handled individually in each module.
As a subject, this research uses music as an example, which is a kind of acoustic multimodal interaction. This study is intended to solve problems involving acoustic human interface, multimodal interaction, synchronization, and internal expression similar to physical space sound. Last year, we studied the concept of logical time, and created an experimental system WALTZ which generated a single melody using logical time.
This paper describes an accompaniment system that uses internal acoustic expression and time management concepts in multimodal interaction based on the logical time concept. In this system the studio is regarded as a space and data are written as sounds in the studio. Synchronization is performed according to differences with the other players.

A Cooperative Mechanism for Acoustic Multimodal Interaction

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Institute for Personalized Information Environment

We consider distributed cooperative architecture such as the Agency Model to be suitable for multimodal processing. This paper proposes a cooperative mechanism for acoustic multimodal interaction and describes its implementation based on the Agency Model. The cooperative mechanism is derived from a model of acoustic multimodal interaction. We regard acoustic multimodal interaction as mainly consisting of three major modes: sound length (tempo), frequency, and amplitude. This research was conducted to search for an interaction mechanism when agents in the Agency Model are assigned to the communication modes. To simplify the issue, this study is limited to certain modes in terms of sound length. As an example, a music accompaniment system has been designed and built based on the cooperative mechanism. The accompaniment system shows that the cooperative mechanism is effective under the following circumstances: When a mode that is not anticipated by the system exists on the soloist side, when knowledge is added to the soloist side, and when an agent is plugged into the accompaniment system, because each agent need not explicitly consider to which agent a transfer should be made.

"PAINT IT BLACK"
- A Multimodal Drawing Tool -

Mayumi Hiroshi
NEC Corporation

A multimodal user interface allows users to communicate with computers by using multiple modalities, such as a mouse, a keyboard, or a voice input, in various combined ways. In such a system, individual input/output modes have to work independently and cooperatively. Agency Model proposed by FRIEND21 Project is a framework where several independent agents work cooperatively (1). So it is suitable as an architecture for a multimodal interface. This paper discusses a multimodal interface for a drawing tool, especially focusing on multimodal inputs. First, the author describes the multimodal interface positioning used in the study, as well as multimodal inputs in a drawing tool. Next, a prototype system, developed based on Agency Model, and it's multimodal inputs interpretation method are described.

Information retrieval process based on structured data

Makoto Nishida
Dai Nippon Printing Co., Ltd.

A problem of Human Interface for retrieving multimedia information, e.g. music, photograph, and movie, are complicated methods for retrieving. At present, methods for retrieving multimedia information are studied individually in each media. To retrieve simultaneously multimedia information in the present state of things, we expect that methods for retrieving are difficult, and we cannot find out easily needed information.
To make retrieval easy, it is necessary to be able to retrieve multimedia information by common methods. For the purpose, multimedia information should be represented by single media. We must categorize them. And we must study how to utilize them to retrieve easily multimedia information.
For doing so, we aimed to represent multimedia information by texts, and to retrieve them via the texts. First, we analyzed retrieval methods based on texts, e.g. dictionary. We extracted structures of information for retrieval that users aren't conscious of differences in media, and categorized them. The structured information were represented by texts. Secondly, we studied the mechanism that users can freely choose an appropriate function in response to a transition of the user's states in retrieval processes.
In this paper, we suggest retrieval processes based on structured texts data for multimedia information retrieval. We describe a prototype system based on the new concept, and a experiment on the system.

Information Structure of User Interface for Integration of Text and Images

Shogo Nakagome
Toppan Printing Co., Ltd.

Processing manuscripts on computer systems has been starting point for many of us to become a computer user.
Document processing is one of the most typical and popular forms of computer usage for both novice and expert users. It is very important to provide many users with comfortable environment for document processing.
For document to be effective in conveying information, the system to process documents has to integrate text and images. Word-processors are one of typical electronic document processing systems. Recently, they provide additional functions for processing graphics and spreadsheets. However, word

processors currently available often lack functionalities sufficient to handle editing and layout when processing text and graphics data.
An environment comfortable for a user is in a subtle way different from the one for another. Because each user has different value system, knowledge background, and purpose of usage. However, all users prefer to have the environment where they can make documents without being troubled by different operations between text and images.
What users need now is the environment enabling the integration of text and images in a natural form.
This paper describes a definition of information structure to integrate both text and images, and its implementation as well.

Implementation of a User Adaptation Mechanism on the Agency Model

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With recent progress in computer science, people have become familiar with computer systems. For example, home computer games are treated like domestic electronic goods. However, the usability of these systems varies. In some recent applications, the button assignments can be changed by the user because his viewpoint may be different from that of the application designer. The FRIEND21 project of the Japanese Ministry of International Trade and Industry has been promoting research in the field of Human-Computer Interaction since 1988. For example, Metaware (7) and the Agency Model (6) are its outcome. As part of this project, we have engaged in a research on an adaptive interface that can be changed according to the user preference in order to improve its usability.
Rich proposed a basic idea for this interface, that is to transform the canonical model according to the individual user operations (5). Croft explained the adaptive method according to the user's operational context (1). Greenberg et al. proposed the system that detects the most frequently used menu by utilizing a tree structure and the frequency of usage, and then transforms the menu structure (3). In this method, the menu structure is transformed dynamically according to user operations, but objects operated on by the menu are not considered. Cypher reported a prototype system, Eager (2), run on Macintosh's HyperCard system. Eager monitors user operations, detects repetitions, and offers to automate them. Eager considers the menu operation, but does not handle sequences that are not repeated including mistaken operations.
In this paper, we propose a user adaptation mechanism that consists of two adaptive methods and show our prototype implementation of these methods. One method which deals with functional sequences takes into account objects operated on by functions and user context. The other method deals with functional parameters.
In Section 2, we propose a user adaptation mechanism consisting of the above two methods. ;In Section 3, we give the specifications of prototype that implements two adaptation methods for a motion picture editing system. In Section 4, we discuss problems of the prototype and explain improvements to the system. In Section 5, we summarize results.

User adaptation by task intention identification

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Even users with an understanding of the internal processes of a computer system may not understand how to operate such a system most efficiently. Therefore, many researchers have pointed out the importance of a metaphor interface that provides a conceptualized model of the system's operation, thereby drawing upon a user's current knowledge and skills (1)(2).
Nevertheless, a metaphor interface is not without its problem so if the user develops a concept from the metaphor that is different from the designer's original intention the system may not function as expected, and may therefore confuse the user.
Such problems arise from a lack of understanding about what the metaphor means to the user. The metaphor interface involves mapping between the functions of an application and the visual objects of the metaphor. Most problems are caused by improper mapping.
Moreover, a user's actions may change depending on the situation. Normally, a computer is used either to acquire or express knowledge. The user performs a sequence of operations to extract this knowledge. As such, different task intentions require different sequences of individual operations.
A computer system that can take into consideration a user's task intentions can support the particular methods he uses intuitively. The user is thus, free to concentrate on the task itself without being distracted by other concerns.
The aim of this research is to allow the mapping to be adapted to each situation through the use of a mechanism that identifies the user's situation, particularly the task context. In this way, the system can eliminate incomplete mapping between application functions and metaphor objects.
We believe that it is possible to obtain part of the task context from the user's operation history. The prototype we have developed makes decisions about which function to perform based on the task contexts from the user's operation history. Using this system, we examined the mapping mechanism to see if it would work properly.

Filtering Software Products and Advertising Software Products: Two Sides of the Same Coin?

Masashi Uyama
FRIEND21 Research Center

Software products provide many software services to support users' task executions. In an open network environment, where newly designed software products are frequently disseminated and installed, computer systems should help users find useful software services and integrate such services into their tasks. This paper proposes a three-step filtering mechanism to support a user's mental process through which the user passes from first awareness-knowledge of new software services to a decision about adopting or rejecting such services. The filtering mechanism selects services that trustworthy colleagues have recommended, and then, selects services specific to the context of the user's task executions. Finally, the mechanism discloses the selected services to the user dynamically and unobtrusively. The dynamic

disclosure allows users to try out new services in their own task context. The disclosure is unobtrusive since users can ignore the disclosure and continue their current tasks without learning any of the new features. The three-step filtering mechanism has been implemented based on the Agency Model.

6. Sponsor's Demonstration Projects

A total of fifteen demonstration projects were available for view during scheduled interactive sessions on each of the three days of the symposium. All of the demonstration projects concern either Metaware Development or Agency Model related tasks. Each is listed below, along with the researchers' names and organizations. All are associated with companion presentations (identifiable by combinations of title, author and organization) abstracted in section 5.

Metaware Development

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MECOT" Metaphor Environment COnstruction Tools
Nobuo ASAHI, Shoji TANAKA and Akira MAENAKA
MITSUBISHI ELECTRIC CORPORATION

Class based dynamic user interface environment
Masaya UEDA
SHARP CORPORATION

Browser and Examiner of Knowledge Base of Visible Software Parts
Toshihiko SHIIROKAZE
Oki Electric Industry Co., Ltd.

Sound metaphors in 3D space
Michio MIWA, Hiroyuki HIKITA, Hironobu SUZUKI and Noritoshi OGASAWARA
MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.

A Metaphor Environment Based on Interactive Scenarios
Keiko SAKURAGI and Fumitaka KAWATE
Sony Corporation

Visualizing Information by Metaware
Nobuyuki MAKIMURA, Tatsuya KAINUMA and Makoto MIZUYAMA
FUJITSU LIMITED

Collaborative Manipulation Interface

Takashi SONODA and Mitsuhisa KAMEI
Fuji Xerox Co., Ltd.

User adaptation by a task intention identification

Kazuhisa OKADA
FRIEND21 Research Center

Agency Model

Synchronization for Accompaniment System

HIDAI Yutaka
FRIEND21 Research Center

Acoustic Multimodal Interaction on Accompaniment System

Takeshi SUGAI
FRIEND21 Research Center

On-Line Handwriting Recognition Based on Agency Model

Koji YURA, Akinori KAWAMURA and Tatsuya HAYAMA
TOSHIBA CORPORATION

Paint It Black - A Multimodal Drawing Tool

Mayumi HIYOSHI, Hideo SHIMAZU, Kenichi OMACHI and Yosuke TAKASHIMA
NEC Corporation

Video Demonstration of a prototype system for retrieving paintings

Tadashi SAITO, Yoshinori KAWAKAMI, Akemi KANEKO and Makoto NISHIDA
DAINIPPON PRINTING CO., LTD.

Information structure of user interface for integration of text and images

Shogo NAKAGOME and Motoichi NAKAMURA
TOPPAN PRINTING CO., LTD.

Implementation of a User Adaptation Mechanism on the Agency Model
Shigeo SUMINO and Mitsuru IKEZAWA
Hitachi, Ltd.

A Three Step Filtering Mechanism
Masashi UYAMA
FRIEND21 Research Center

7. Some FRIEND21 Background Papers

Following are titles of some English language FRIEND21 background papers reviewed during the preparation of this report. Some are FRIEND21 Research Center reports and others are published as indicated. All were provided by Mr. Kenji Seno of P.I.E.

FRIEND21 Project: A Construction of 21st Century Human Interface
Hajime Nonogaki and Hirotada Ueda
FRIEND21 Research Center

FRIEND21 Project, SIGCHI Bulletin, Volume 25, Number 2, April 1993
Hirotada Ueda
FRIEND21 Research Center

A Construction of Direct Engagement for Human Interface and Its Prototyping, IEICE Trans. Fundamentals, Vol. E-75A, No. 2, February 1992
Hajime Nonogaki, Norikazu Saito, Nobuo Asahi and Makoto Hirose
(All are with FRIEND21 Research Center except Saito who is with DAINIPPON PRINTING COMPANY, LTD.)

A Construction of Direct Engagement for 21st Century Human Interface, 6th Symposium on Human Interface, Oct. 24-26, 1990, Tokyo
Hajime Nonogaki
FRIEND21 Research Center

Strategy for Managing Metaphor Mismatching, CHI '92, ACM Conference on Human Factors in Computing Systems, Monterey, California, May 3-7, 1992.
Makoto Hirose
FRIEND21 Research Center

A Study of Personal Adaptation of Metaware, 6th Symposium on Human Interface, Oct. 24-26, 1990, Tokyo
Nobuo Asahi and Makoto Hirose
FRIEND21 Research Center

PLOTS: An interaction paradigm and an experiment in 3D shape manipulation
Michio Miwa, Takamasa Oyama, Miwa Fukino, Masao Kato
Tokyo Research laboratory, Matsushita Electric Industrial Co., Ltd.

IMPACT: An Interactive Natural-Motion-Picture Dedicated Multimedia Authoring System
Hirotada Ueda, Takafumi Miyatake, and Satoshi Yoshizawa
Central Research laboratory, Hitachi, Ltd.

Automatic Structure Visualization for Video Editing
Hirotada Ueda, Takafumi Miyatake, Shigeo Sumino and Akio Nagasaka
Central Research laboratory, Hitachi, Ltd.

Interactive Video Editing Supported by Image Recognition Technology
Hirotada Ueda
Central Research laboratory, Hitachi, Ltd.

A Blackboard-based Architecture for Filtering New Software Features
Masashi Uyama
FRIEND21 Research Center